

CHAPTER 41

QUALITY OF CARE IN PEOPLE WITH DIABETES

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SUMMARY

This chapter provides an overview of data and perspectives regarding quality of care in diabetes. The evidence base behind metrics used to assess the quality of diabetes care is reviewed, and the degree to which diabetes care in the United States meets definitions of high-quality care at the levels of the organization and the individual is investigated.

Risk factor control has improved over the past two decades, but substantial gaps remain between current treatment recommendations and the quality of care received by persons with diabetes in the United States. Among persons with diagnosed diabetes, the prevalence of calibrated glycosylated hemoglobin (A1c) <7.0% in 1988–1994 was 50.9% compared to 58.8% in 2005–2010. Overall age-standardized blood pressure control has improved over time, with 32.8% of persons with diagnosed diabetes achieving <130/80 mmHg in 1988–1994 compared to 50.5% in 2005–2010. Age-standardized cholesterol control has improved dramatically; 33.2% of persons with diabetes had total cholesterol <200 mg/dL in 1988–1994 compared to 67.0% in 2005–2010.

Racial disparities are of particular concern, as substantial differences in the prevalence of A1c <7.0% by racial/ethnic groups remain. In 2005–2010, non-Hispanic blacks (53.9%) and Mexican Americans (47.7%) with diabetes were less likely to have a calibrated A1c <7.0% compared to non-Hispanic whites (61.1%).

National data reveal gaps in care related to neuropathy and retinopathy among persons with diabetes, suggesting that many patients are not meeting standard of care recommendations. In 2005–2010, 28.6% of adults with diabetes had not had their feet checked by a health professional within the past year, and 18.8% had never conducted a self-exam on their feet. Receipt of eye care has increased over time, with 63.7% of adults with diabetes reporting having received a dilated eye exam within the past year in 2005–2010 compared to 54.4% in 1988–1994.

General clinical recommendations for risk factor management in diabetes, focused on prevention and treatment of microvascular and macrovascular conditions, largely define the emphasis of high-quality care. However, this focus on individual treatment targets has several limitations. One challenge is that cardiovascular risk factor treatment advice and guidelines for patients with diabetes are issued by a wide array of stakeholder groups and recommendations often differ; cooperation across guideline development groups has improved but remains suboptimal. Further, the focus only on the “ABCs” of A1c, blood pressure, and cholesterol for improving diabetes care, particularly when tied to treatment targets, may not be appropriate for all patients. Other measures, such as prevention of diabetes, hypoglycemia, patient satisfaction, quality of life, infections, or recurrent hospitalizations, among others, could be considered.

The chapter concludes with a discussion of areas in most need of improvement. Extending quality of care standards to address novel indicators could improve outcomes for individuals and also may help identify system factors that could improve care across the population.

WHAT IS QUALITY?

Health care systems throughout the world are struggling to improve the health of their populations, with constrained budgets. Increasingly, these systems are deploying

new value-based approaches to financing that reward or penalize organizations and providers depending on the quality of care that they provide (1,2). As a consequence,

defining and measuring the quality of health care are essential steps in efforts to improve the performance of health care systems, to ensure the efficient use

of health care resources, and ultimately to improve the health of populations. Benchmarks of quality are also needed for individual providers and patients who are making everyday treatment and diagnostic testing decisions. While there is no question that measures of the quality of health care are needed, the actual definition of quality in health care has been elusive and controversial for decades.

In a 1990 report, the Institute of Medicine defined quality as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” (3). The U.S. Agency for Healthcare Research and Quality (AHRQ) defines its overall focus on safety and quality as that to “reduce the risk of harm by promoting delivery of the best possible health care.” Classically, quality is defined as the extent to which health care improves important patient outcomes (4).

In his landmark work on evaluating quality of care, Donabedian highlighted the multidimensional properties of quality (5). He conceptualized a model of health care quality with three key components: structure (the setting in which care takes place), process (how care

is provided), and outcomes (survival or improvement in health status). Indeed, this multidimensionality makes health care quality hard to define. For patients, satisfaction with care may contribute substantially to ratings of quality. Waiting times, spaciousness, furnishings, layout of facilities, and technology used during a health care interaction can influence perceptions of quality of care (6,7,8). For health care providers, working conditions, facilities, institutional policies, regulations, supervision, and organizational structure may influence perceptions of the quality of care being provided. Outcomes may be the more concrete metrics that lend themselves to relatively precise measurement, but they can be influenced by many factors both inside and outside the health care system (5). And indeed, choosing the most relevant outcome is critical.

The definition of high-quality care in diabetes is actively evolving but has generally focused on beneficial interactions among patients and health care teams, the community, and the health care system (9). Originally organized by leading diabetes stakeholders, the National Diabetes Quality Improvement Project (DQIP) developed a national set of performance and outcomes

measures (10). These measures have been adopted by various organizations for quality improvement activities, namely, the Healthcare Effectiveness Data and Information Set (HEDIS), the American Diabetes Association Provider Recognition Program, the American Medical Association Diabetes Measures Group, the Department of Veterans Affairs performance monitoring program, and others. DQIP has since evolved to widen its partnership base and become a coalition of influential private and public national organizations, changing its name to the National Diabetes Quality Improvement Alliance, and later to the Diabetes Advocacy Alliance.

The major parameters by which quality of care in diabetes has been historically judged at the level of the individual are control of glucose, lipids, and blood pressure, and receipt of services, such as regular eye and foot care examinations. The evidence base for this focus comes from large, randomized clinical trials designed to evaluate strategies to prevent microvascular and macrovascular complications in persons with diabetes. But, the clinical practice guidelines used to guide treatment of the individual are often distinct from quality standards and quality improvement priorities (11).

THE EVIDENCE BASE FOR DEFINITIONS OF HIGH-QUALITY CARE IN DIABETES

Glycosylated hemoglobin (A1c) is the primary measure for monitoring glucose control in persons with diabetes. In the past, the American Diabetes Association (ADA) and other organizations have recommended targeting A1c levels to below or around 7.0% (53 mmol/mol), based on evidence from clinical trials showing reductions in microvascular complications (12,13,14,15). However, the scientific basis to support this threshold in the modern era is more controversial. In 1993, the Diabetes Control and Complications Trial (DCCT) in type 1 diabetes demonstrated major reductions in the development and progression of microvascular disease among patients achieving A1c <7.0% compared to the conventionally treated

group (A1c >9.0% [>75 mmol/mol]). In type 2 diabetes, evidence for pegging glycemic control targets at 7.0% initially came from the landmark United Kingdom Prospective Diabetes Study (UKPDS), published in 1998, which demonstrated major reductions in microvascular outcomes (relative risk reduction of 25% for combined microvascular endpoints, $p=0.0099$) and a smaller and nonsignificant reduction in myocardial infarction with improved glycemic control (relative risk reduction of 16%, $p=0.052$) among persons with newly diagnosed diabetes (15). Persistent benefits of glycemic control for both microvascular and macrovascular outcomes have been shown in long-term observational follow-up of participants in both the DCCT and UKPDS

studies (16,17,18,19). Notably, these trials were conducted in an era prior to the widespread use of statins and when there was less focus on tight blood pressure control as part of routine diabetes care.

More recent randomized clinical trials in persons with diabetes failed to show benefit of very intensive glycemic control on macrovascular outcomes and perhaps even harm (20,21,22,23,24). Consequently, there is controversy regarding whether a focus on very tight glycemic control produces overall benefit in type 2 diabetes, particularly among older adults and those with longstanding disease (25). Thus, nonglycemic risk factors comprise the focus of macrovascular risk reduction strategies in diabetes,

along with an emphasis on individualizing treatment targets and a de-emphasis on specific thresholds.

Clinical practice guidelines from the ADA and the American Heart Association specify control of blood pressure and lipids, treatment with aspirin therapy, and smoking cessation as the major strategies to reduce cardiovascular risk among persons with diabetes (26,27). It is noteworthy that the 2013 ADA clinical practice guidelines revised the systolic blood pressure control recommendation to a less stringent target of <140 mmHg compared to the previously recommended goal of <130 mmHg. This revision reflects evidence from clinical trials and meta-analyses that suggests little to no additional benefit and possible harm of very strict blood pressure control compared to “usual care” (typically <140 mmHg) (28,29,30,31,32,33). ADA guidelines suggest that the lower target of <130 mmHg may be appropriate in

certain subpopulations, such as young persons, if the target can be achieved without “undue treatment burden” (34).

The ADA recommends that persons with diabetes be screened annually with a fasting lipid profile, and statin therapy is broadly recommended. Among persons with diabetes and no history of cardiovascular disease, moderate to high doses of statins are recommended to lower cholesterol. These recommendations are based on strong evidence from randomized clinical trials and meta-analyses demonstrating significant primary and secondary prevention of cardiovascular disease in the setting of diabetes (34,35), similar to the benefits observed in nondiabetic populations (36,37). However, the literature regarding specific low-density lipoprotein (LDL) cholesterol thresholds is sparse, and recommendations for thresholds are not based on large studies that have specifically targeted such levels. Aspirin is also recommended as a primary cardiovascular disease prevention strategy

in those persons with diabetes who have increased cardiovascular risk (most older persons and persons with additional cardiovascular risk factors), although the benefits of aspirin must be weighed against its harmful side effects, including serious bleeding events (34,38).

These general clinical recommendations for risk factor management in diabetes, focused on prevention and treatment of microvascular and macrovascular conditions, largely define the emphasis of high-quality care in persons with diabetes. A challenge is that cardiovascular risk factor treatment advice and guidelines for patients with diabetes are issued by a wide array of stakeholder groups, and recommendations often differ from that of the ADA; cooperation across guideline development groups has improved but remains suboptimal. Moreover, as shown below, substantial gaps remain between the ADA recommendations and the quality of care received by persons with diabetes in the United States (39,40,41,42).

TRENDS IN DIABETES RISK FACTOR CONTROL: RESULTS FROM THE NHANES

Multiple studies have tapped national datasets to examine quality of diabetes care at the level of the individual. In particular, national data demonstrate a significant gap between clinical recommendations and A1c, blood pressure, and cholesterol control in persons with diabetes in the United States (40,41,42,43,44,45, 46,47,48,49). In general, the literature demonstrates improvements in control of glucose and cardiovascular risk factors among persons with diabetes over the past several decades; however, in most studies, substantial portions of persons with diabetes do not meet recommended treatment goals. New analyses were conducted for *Diabetes in America, 3rd edition*, to examine trends in risk factor control across multiple rounds of the National Health and Nutrition Examination Survey (NHANES).

THE NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEYS

The NHANES are cross-sectional, multistage, stratified, clustered probability samples of the U.S. civilian

noninstitutionalized population conducted by the National Center for Health Statistics, a branch of the Centers for Disease Control and Prevention. The NHANES includes interview and examination components (including blood collection). The NHANES are among the most important sources of information on the health of the nation and provide comprehensive information on diabetes and its risk factors in the general U.S. population. Analyses were conducted for *Diabetes in America* based on the Third NHANES (NHANES III) (1988–1994) and from six rounds of the continuous NHANES (1999–2010), reported in 2-year intervals. Because individual estimates from the 2-year cycles are inherently more imprecise due to the smaller sample size, focus was given to the NHANES 1988–1994, 1999–2004, and 2005–2010 periods to provide the most stable estimates. The estimates reported here are nationally representative of U.S. populations either by age-standardizing to the general population of the 2010

U.S. Census or to the diabetic population of the National Health Interview Surveys 2009–2010. To adjust for demographic shifts in the population of persons with diabetes, age of diagnosis and diabetes duration were standardized to the National Health Interview Survey 2010 diabetes population by sex and race.

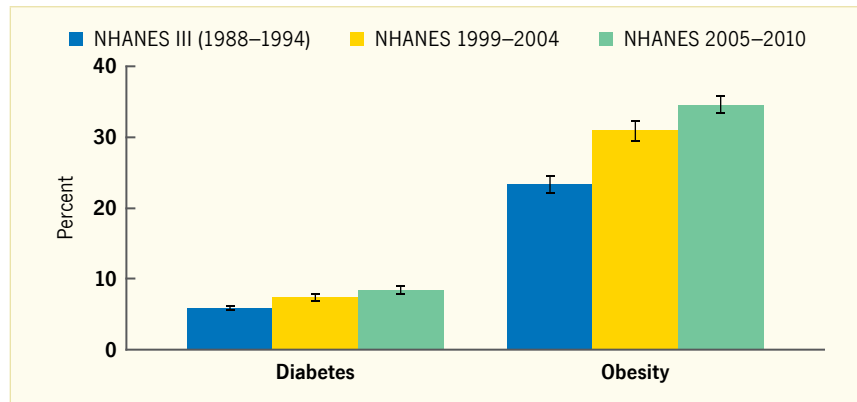
RISK FACTOR CONTROL AMONG PERSONS WITH DIAGNOSED DIABETES

In the overall adult population, the age-standardized prevalence of diagnosed diabetes has increased from 5.9% in the NHANES 1988–1994 to 7.4% in 1999–2004 and 8.4% in 2005–2010, along with parallel increases in the prevalence of obesity over these periods (Figure 41.1). Estimating trends in glycemic control (A1c levels) in the U.S. population has been complicated by the challenges of maintaining a constant calibration of the A1c assays in the NHANES over the past two decades. After accounting for laboratory drift, trends in glycemic control

(A1c <7.0% or <8.0% [<64 mmol/mol]) among persons with diagnosed diabetes show clear improvements in the past 20 years (50). Among persons with diagnosed diabetes, the prevalence of calibrated A1c <7.0% in the NHANES 1988–1994 was 50.9% compared to 58.8% in 2005–2010. The prevalence of calibrated A1c <8.0% in persons with diagnosed diabetes in 2005–2010 was 79.4%. Among persons with a diagnosis of diabetes who did not report taking diabetes medication in 2005–2010, the prevalence of calibrated A1c <8.0% was over 90% (50). There have also been major increases in the use of oral diabetes medications and a decline in insulin-only use in persons with diabetes over this period (Table 41.1). In 2005–2010, 13.5% of persons with diagnosed diabetes reported no medication use, down from 25.7% in 1988–1994.

Overall blood pressure control has improved over time, with 32.8% of persons with diagnosed diabetes achieving <130/80 mmHg in 1988–1994 compared to 50.5% at the NHANES 2005–2010 examinations (Figure 41.2). Using a less stringent goal of <140/90 mmHg, the corresponding percentages were 61.6% and 71.3%, respectively. Cholesterol control has improved dramatically: 33.2% of persons with diabetes had total cholesterol <200 mg/dL (<5.18 mmol/L) and 10.7% had LDL cholesterol <100 mg/dL (<2.59 mmol/L) in 1988–1994 compared to 67.0% and 55.0% in 2005–2010, respectively (Figure 41.2). Correspondingly, medication treatment for lowering blood pressure and cholesterol has increased over the past two decades, with more than half of all persons with diagnosed diabetes reporting current medication use for hypertension or high cholesterol in 2005–2010 (Table 41.1). Blood pressure control (<130/80 mmHg) in diabetic individuals treated for high blood pressure has improved dramatically from 17.1% in 1988–1994 to 43.5% in 2005–2010. The proportion of persons with diabetes treated for high cholesterol who had total cholesterol <200 mg/dL increased from 30.9% in 1988–1994 to 65.4% in 2005–2010. The gains in lipid

FIGURE 41.1. Age-Standardized Trends in Diagnosed Diabetes and Obesity Among Adults Age ≥ 20 Years, U.S., 1988–1994 and 1999–2010



Obesity is defined as body mass index ≥ 30 kg/m². Estimates are standardized to the 2010 U.S. Census using age groups 20–44, 45–64, and ≥ 65 years. Error bars represent 95% confidence intervals.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

TABLE 41.1. Age- or Sex/Race-Standardized Trends in Risk Factor Control Among Adults Age ≥ 20 Years With Diagnosed Diabetes, U.S., 1988–1994 and 1999–2010

RISK FACTORS	NHANES III 1988–1994 (N=1,496)	NHANES 1999–2004 (N=1,536)	NHANES 2005–2010 (N=1,990)
Mean (standard error)			
Age at diabetes diagnosis (years)	50.6 (0.57)	46.3 (0.70)	48.6 (0.54)
Duration of diabetes (years)	9.2 (0.35)	12.9 (0.54)	10.8 (0.29)
Percent (standard error)			
Diabetes treatment*			
Insulin only	26.0 (1.57)	15.5 (1.48)	14.8 (1.07)
Oral only	44.5 (2.50)	56.1 (1.82)	57.4 (1.85)
Insulin and oral	3.7 (0.60)	10.6 (1.41)	14.4 (0.88)
No meds	25.7 (1.97)	17.8 (1.64)	13.5 (1.31)
Hypertension			
Treated*	47.0 (2.01)	56.3 (1.58)	63.0 (1.50)
Controlled†	17.1 (2.93)	34.2 (2.38)	43.5 (1.87)
Uncontrolled	82.9 (2.93)	65.8 (2.38)	56.5 (1.87)
Hypercholesterolemia			
Treated*	14.8 (1.64)	40.6 (1.90)	53.7 (1.67)
Controlled†	30.9 (6.65)	47.5 (3.07)	65.4 (2.35)
Uncontrolled	69.1 (6.65)	52.5 (3.07)	34.6 (2.35)
Daily aspirin use	18.5 (1.85)	22.5 (1.83)	‡
Retinopathy§	17.0 (1.51)	25.0 (1.73)	20.7 (1.10)
Retinopathy	20.1 (2.50)	‡	31.9 (1.93)
History of CVD¶	20.2 (2.11)	24.6 (1.61)	23.4 (1.09)
Current smoking	18.6 (2.07)	20.2 (1.27)	16.7 (0.94)

Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥ 65 years, except for diabetes duration, which is standardized by sex and race to the National Health Interview Surveys 2009–2010 diabetic population. Conversions for cholesterol values are provided in *Diabetes in America Appendix 1 Conversions*. CVD, cardiovascular disease.

* Self-reported use of insulin or diabetes pills; self-reported use of medication to lower blood pressure; self-reported use of medication to lower cholesterol.

† Controlled medication-treated hypertension based on blood pressure <130/80 mmHg; controlled medication-treated hypercholesterolemia based on total cholesterol <200 mg/dL.

‡ Not determined.

§ Based on self-report.

|| Based on fundus photography.

¶ Defined as myocardial infarction and congestive heart failure in the NHANES III 1988–1994, as angina and coronary heart disease were not determined; defined as myocardial infarction, congestive heart failure, angina, coronary heart disease in NHANES 1999–2010.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

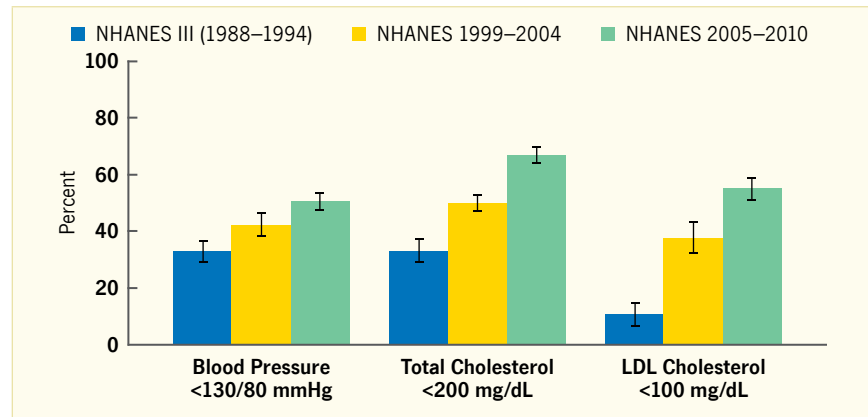
control mirror declining total and LDL cholesterol concentrations and increases in the use of lipid-lowering medications in the overall population (51).

There was a slight increase in prevalence of self-reported retinopathy from 1988–1994 to 2005–2010 (Table 41.1), likely reflecting increased awareness of this condition and improvements in screening and diagnosis (52). The difference in prevalence in 2005–2010 of self-reported (20.7%) and objectively measured retinopathy (31.9%) (Table 41.1) is notable and may reflect both a lack of awareness and lack of receipt of appropriate eye care among persons with diabetes (52). Only a small increase in the prevalence of a reported history of cardiovascular disease was observed over this same period: 20.2% in 1988–1994, 24.6% in 1999–2004, and 23.4% in 2005–2010 (Table 41.1), reflecting both incidence and survival. Indeed, during a time in which use of statins and angiotensin-converting enzyme (ACE) inhibitor use has increased substantially, there have been dramatic declines in rates of cardiovascular complications in persons with diabetes (53). However, there have been much smaller declines in rates of end-stage renal disease, a condition far more specific to diabetes. Interpretation of these trends is complicated by the change in diagnostic criteria for diabetes in 1997, resulting in an increase in rates of diagnosis, and probable increases in routine screening for diabetes in general. It is likely that trends in cardiovascular complications in persons with diabetes reflect a combination of changes in timing of diabetes diagnosis and major improvements in management of cardiovascular risk.

RACIAL/ETHNIC DIFFERENCES IN RISK FACTOR CONTROL

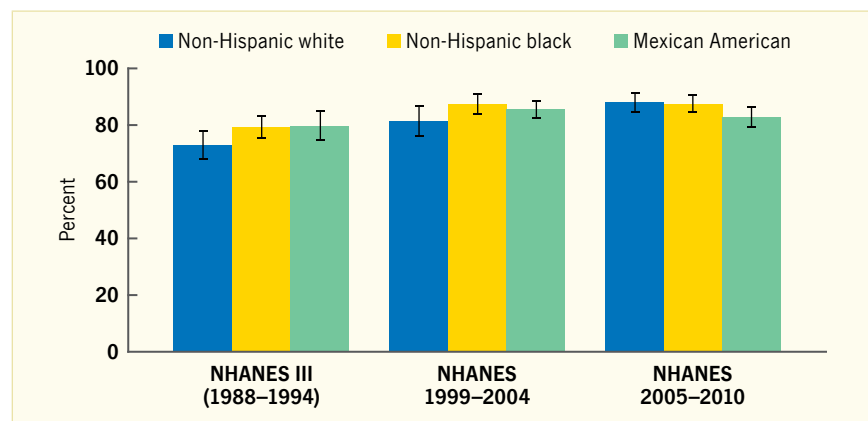
Although glycemic control in persons with diabetes has improved in the population over the past two decades, substantial differences in the prevalence of A1c <7.0% and <8.0% by race/ethnicity remain. In 2005–2010, non-Hispanic blacks with diabetes were less likely to have a calibrated A1c <7.0% compared to non-Hispanic whites (53.9% vs. 61.1%).

FIGURE 41.2. Age-Standardized Trends in Risk Factor Control Among Adults Age ≥20 Years With Diagnosed Diabetes, U.S., 1988–1994 and 1999–2010



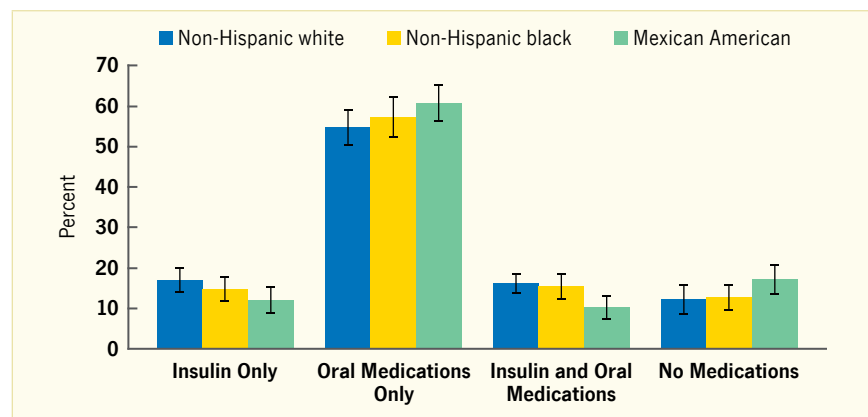
Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. Conversions for cholesterol values are provided in *Diabetes in America Appendix 1 Conversions*. LDL, low-density lipoprotein. SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

FIGURE 41.3. Age-Standardized Use of Any Diabetes Medication Among Adults Age ≥20 Years With Diagnosed Diabetes, by Year and Race/Ethnicity, U.S., 1988–1994 and 1999–2010



Use of insulin or oral diabetes medication is based on self-report. Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. See Appendix 41.1 for further details. SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

FIGURE 41.4. Age-Standardized Diabetes Medication Use Among Adults Age ≥20 Years With Diagnosed Diabetes, by Race/Ethnicity, U.S., 2005–2010



Use of insulin or oral diabetes medication is based on self-report. Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. See Appendix 41.1 for further details. SOURCE: National Health and Nutrition Examination Surveys 2005–2010

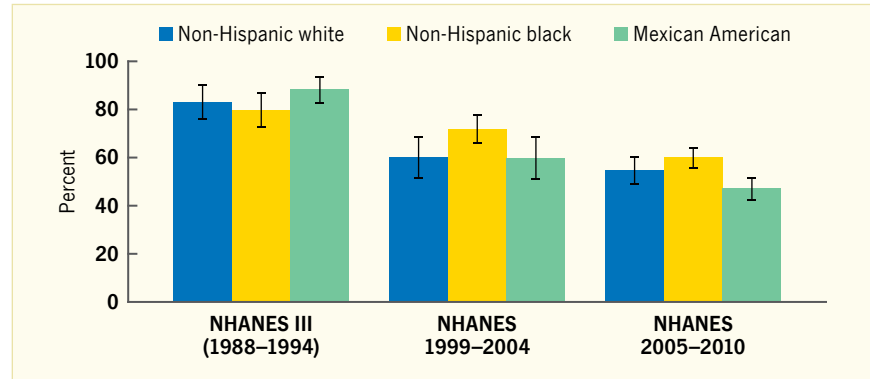
Mexican Americans with diabetes were also less likely to have calibrated A1c <7.0% (47.7% vs. 61.1%) (50). The prevalence and type of diabetes medication use (insulin and/or oral) has also differed somewhat by race over time (Figures 41.3 and 41.4, Appendix 41.1).

Racial/ethnic disparities were also observed for blood pressure and lipid control, with non-Hispanic blacks numerically more likely to have uncontrolled medication-treated hypertension (Figure 41.5, Appendix 41.1) and uncontrolled medication-treated high cholesterol (Figure 41.6, Appendix 41.1) compared to non-Hispanic whites; however, standard errors were large, so it is difficult to determine whether these differences are real. In 1988–1994, the prevalence of retinopathy assessed by fundus photography was numerically higher among non-Hispanic blacks (25.7%) and Mexican Americans (25.8%) compared to non-Hispanic whites (18.8%), but due to the large standard errors for these estimates, it is possible that such differences may be due to sampling variability. Data from the NHANES 2005–2010 show even greater racial disparities numerically in prevalence of retinopathy: 28.7% of non-Hispanic whites, 40.9% of non-Hispanic blacks, and 39.1% of Mexican American (Figure 41.7, Appendix 41.1).

AGE-RELATED DIFFERENCES IN RISK FACTOR CONTROL

Paralleling shifts in the age distribution of the U.S. population, the prevalence of diagnosed diabetes in persons age ≥65 years has increased from 12.8% in 1988–1994 to 16.5% in 1999–2004 and 19.0% in 2005–2010 (Figure 41.8). The trends over time in improvement of risk factor control observed in the overall population are also observed across age groups but with major absolute differences when comparing younger and older persons with diagnosed diabetes (Appendix 41.2). Differences in the burden of microvascular and macrovascular disease by age are especially striking. In 2005–2010, the prevalence of a history of clinical cardiovascular disease was 5.0% in persons age 20–44 years compared to 34.9% of persons age ≥65

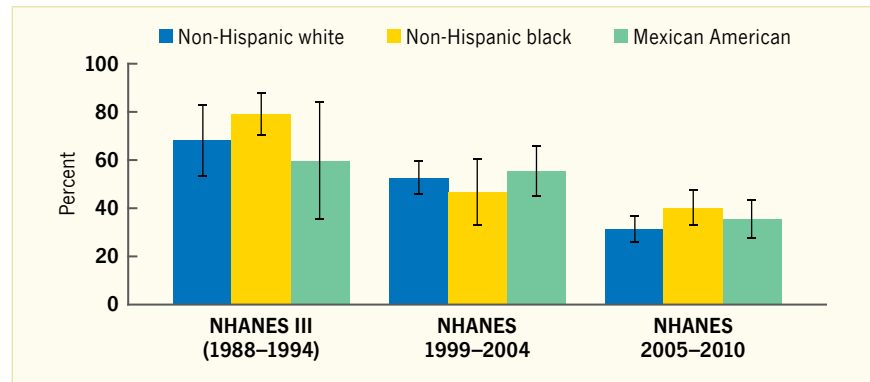
FIGURE 41.5. Age-Standardized Percent Without Hypertension Control Among Adults Age ≥20 Years With Diagnosed Diabetes and Who Are Treated for Hypertension, by Year and Race/Ethnicity, U.S., 1988–1994 and 1999–2010



Controlled medication-treated hypertension is based on blood pressure <130/80 mmHg. Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. See Appendix 41.1 for further details.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

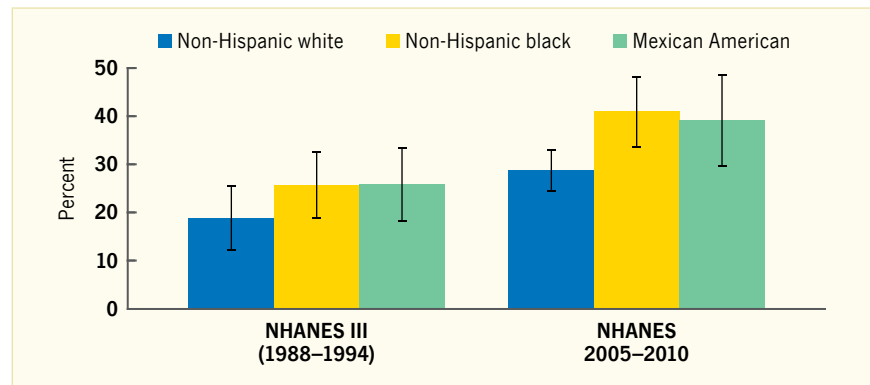
FIGURE 41.6. Age-Standardized Percent Without Cholesterol Control Among Adults Age ≥20 Years With Diagnosed Diabetes and Who Are Treated for Hypercholesterolemia, by Year and Race/Ethnicity, U.S., 1988–1994 and 1999–2010



Controlled medication-treated hypercholesterolemia is based on total cholesterol <200 mg/dL. Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. Conversions for cholesterol values are provided in *Diabetes in America Appendix 1 Conversions*. See Appendix 41.1 for further details.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

FIGURE 41.7. Age-Standardized Percent With Retinopathy Among Adults Age ≥20 Years With Diagnosed Diabetes, by Year and Race/Ethnicity, U.S., 1988–1994 and 2005–2010



Retinopathy is based on fundus photography. Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. See Appendix 41.1 for further details.

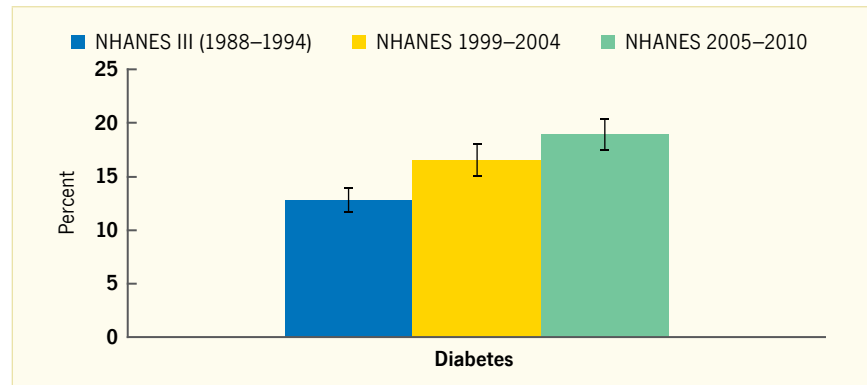
SOURCE: National Health and Nutrition Examination Surveys III (1988–1994) and 2005–2010

years (Figure 41.9, Appendix 41.2), whereas retinopathy (assessed by fundus photography) was present in 20.6% of persons age 20–44 years and 34.7% of persons ≥ 65 years with diabetes (Figure 41.10, Appendix 41.2). For many of these comparisons, however, standard errors are large, so it is not known whether these differences are real. The age-related differences in risk factor control and comorbid illness reflect substantial differences in the case-mix of young versus older persons with diabetes (54). Indeed, the mean duration of diabetes among persons age 20–44 years was 7.6 years compared to 13.5 years among persons age ≥ 65 years (Figure 41.11, Appendix 41.2), and older persons were more likely to be treated with glucose-lowering medications (Figure 41.12, Appendix 41.2). Furthermore, in this cross-sectional setting, age-related differences must be interpreted in the context of “survival bias,” i.e., older persons with diabetes, by definition, had to survive longer to be included in the study. Age-related differences not only reflect demographics, treatment, and diagnostic practices but also survival from the disease and recency of diagnosis (55). For additional discussion of the epidemiology of diabetes in the older population, the reader is referred to Chapter 16 *Diabetes in Older Adults*.

FOOT AND EYE CARE IN DIABETES

Assessments for neuropathy and retinopathy are central to the comprehensive evaluation of the patient with diabetes (34). Education about general foot self-care and annual comprehensive foot examinations are recommended to identify risk factors and prevent ulcers and amputation. Shortly after the initial diagnosis of diabetes, patients should be referred to a specialist for an initial dilated eye examination. Among patients diagnosed with retinopathy, prompt treatment and additional frequent examinations to prevent progression are recommended. Among patients with initially normal eye exams, follow-up may be recommended less frequently (every 2–3 years).

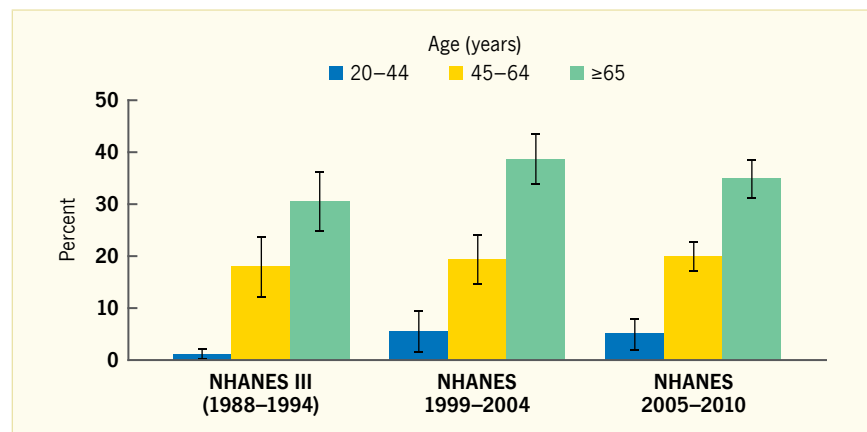
FIGURE 41.8. Trends in Diagnosed Diabetes Among Adults Age ≥ 65 Years, U.S., 1988–1994 and 1999–2010



Estimates are crude and not standardized. Error bars represent 95% confidence intervals.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

FIGURE 41.9. Age-Standardized Percent With Cardiovascular Disease Among Adults Age ≥ 20 Years With Diagnosed Diabetes, by Year and Age, U.S., 1988–1994 and 1999–2010

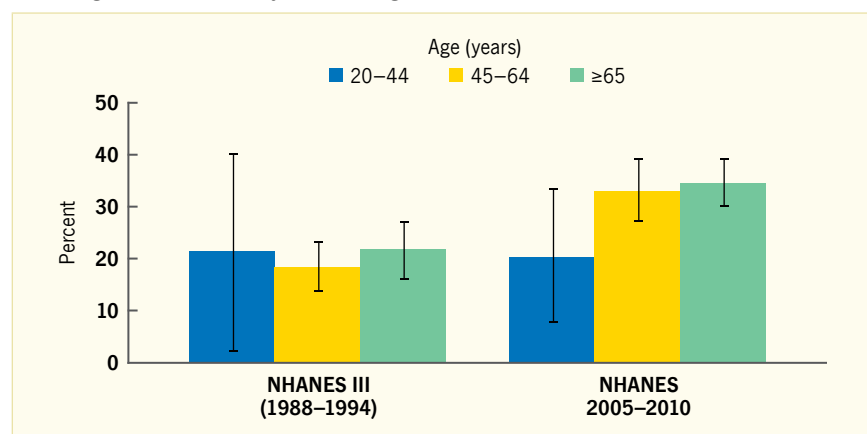


Cardiovascular disease is defined as myocardial infarction and congestive heart failure in the NHANES III 1988–1994 and myocardial infarction, congestive heart failure, angina, coronary heart disease in the NHANES 1999–2010.

Estimates are age-standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥ 65 years. Error bars represent 95% confidence intervals. See Appendix 41.2 for further details.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

FIGURE 41.10. Age-Standardized Percent With Retinopathy Among Adults Age ≥ 20 Years With Diagnosed Diabetes, by Year and Age, U.S., 1988–1994 and 2005–2010



Retinopathy is based on fundus photography. Estimates are age-standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥ 65 years. Error bars represent 95% confidence intervals. See Appendix 41.2 for further details.

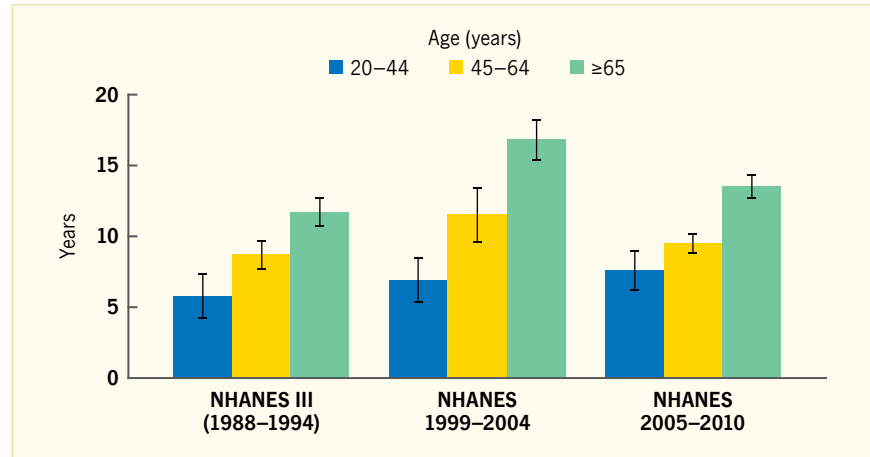
SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 2005–2010

Despite these recommendations, national data (NHANES 2005–2010) suggest major gaps in the foot and eye care being received by patients with diabetes in the United States. Indeed, 28.6% of persons with diagnosed diabetes report that they had not had a health professional check for sores or irritations on their feet in the past year (Figure 41.13). Further, 18.8% of adults with diabetes report that they have never conducted a “self-check” for sores or irritations on their feet (Figure 41.14). Reports of receipt of eye care have improved over time, with 63.7% of persons with diabetes reporting a recent (“in the past year”) dilated eye exam in the NHANES 2005–2010 compared to only 54.4% in 1988–1994 (Figure 41.15). Of concern, 7.1% of patients report never having had an eye examination in 2005–2010 (down from 14.2% in 1988–1994) (Figure 41.15).

DISCUSSION

These results confirm that risk factor control in persons with diagnosed diabetes improved over the past two decades. But, despite these improvements and well-established guidelines for glycemic and cardiovascular risk factor control, a large proportion of the general population of persons with diabetes is still not meeting recommended targets for care. Racial disparities in risk factor control are troubling, with Mexican Americans least likely to have A1c levels <7.0% or <8.0% compared to non-Hispanic whites or blacks (50). In 2005–2010, the prevalence of blood pressure <130/80 mmHg was 51.6% in non-Hispanic whites, 43.4% in non-Hispanic blacks, and 53.0% in Mexican Americans with diabetes (Figure 41.16). The prevalence of LDL cholesterol <100 mg/dL was 61.7% in non-Hispanic whites, 42.0% in non-Hispanic blacks, and 43.8% in Mexican Americans (Figure 41.17). Data from the Behavioral Risk Factor Surveillance System 2010 show that major gaps persist in the receipt of standard foot and eye care that is critical for the prevention of neuropathy and retinopathy (Figure 41.18) (56). Given the availability of highly effective therapies

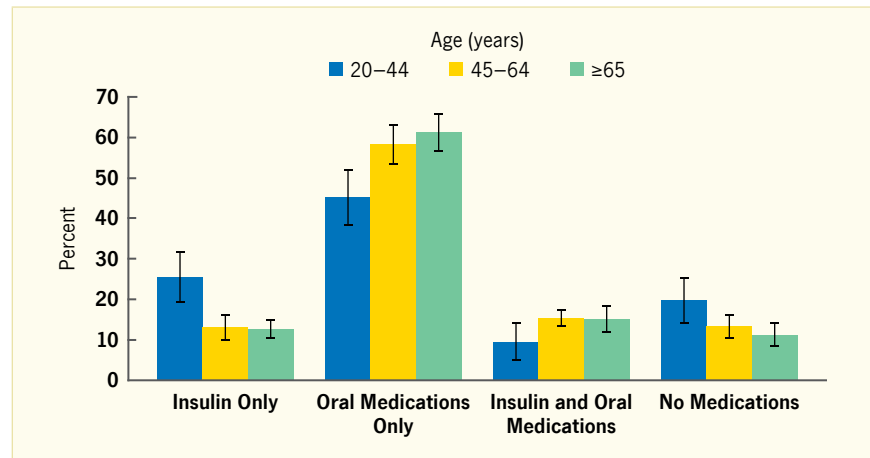
FIGURE 41.11. Sex-Standardized Mean Duration of Diabetes Among Adults Age ≥20 Years, by Year and Age, U.S., 1988–1994 and 1999–2010



Estimates are standardized by sex to the National Health Interview Surveys 2009–2010 diabetic population. Error bars represent 95% confidence intervals. See Appendix 41.2 for further details.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

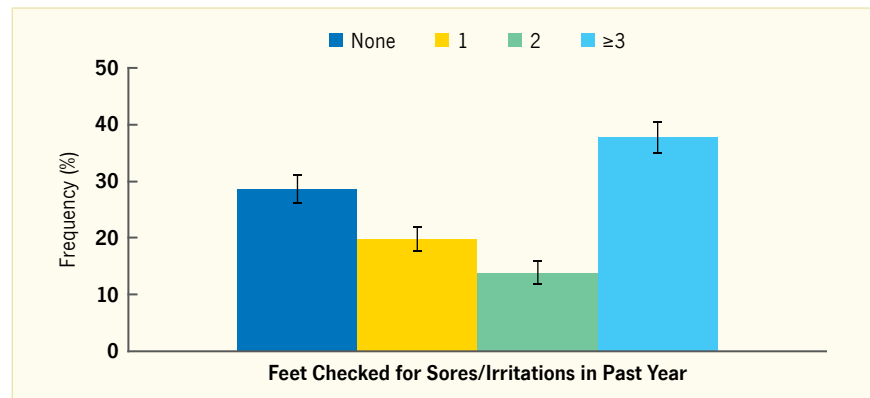
FIGURE 41.12. Age-Standardized Diabetes Medication Use Among Adults Age ≥20 Years With Diagnosed Diabetes, by Age, U.S., 2005–2010



Use of insulin or oral diabetes medication is based on self-report. Estimates are age-standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. See Appendix 41.2 for further details.

SOURCE: National Health and Nutrition Examination Surveys 2005–2010

FIGURE 41.13. Frequency of Number of Times Feet Were Checked for Sores/Irritations in the Past Year by a Doctor Among Adults Age ≥20 Years With Diabetes, U.S., 2005–2010



Data are self-reported. Error bars represent 95% confidence intervals.

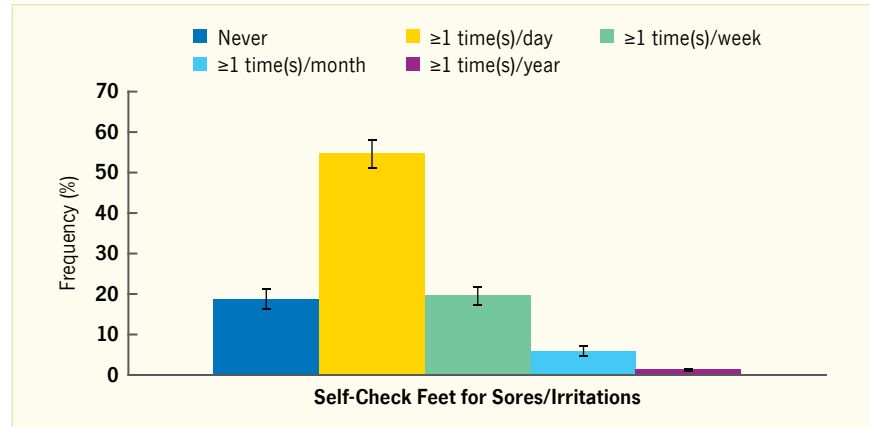
SOURCE: National Health and Nutrition Examination Surveys 2005–2010

for diabetic retinopathy, the overall low awareness of this condition is particularly concerning.

In addition to major changes in risk factor treatment and control since the 1980s, the characteristics of persons with diagnosed diabetes have changed over this period. Some of these changes are undoubtedly due to changes in screening and diagnostic practices—notably, the lowering of the fasting glucose threshold for diagnosis of diabetes from 140 mg/dL (7.77 mmol/L) to 126 mg/dL (6.99 mmol/L) in 1997. Furthermore, the proportion of cases of diabetes that are undiagnosed has decreased over the past 20 years, likely reflecting changes in screening and diagnostic practices (50). The observed age-related differences in burden of the disease and the increase in the overall reported average duration of the disease among those persons with diagnosed diabetes may also reflect earlier diagnosis, longer survival of people with the disease, and other demographic changes that have occurred over the past two decades. Observed trends in risk factor control are also driven by the availability of new medications and changes in clinical recommendations and prescribing practices (57).

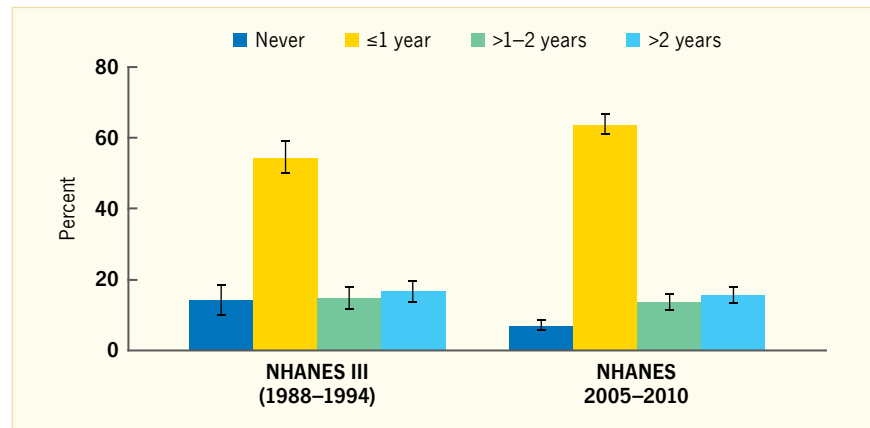
Age-related differences in risk factor control reflect a complex mix of factors that include disease severity and duration, survival, health care access and use, comorbid conditions, and diagnostic and treatment practices. Age-related disparities may also reflect a combination of bias and concerns regarding overtreatment in the elderly. Among older adults with possibly limited lifespans, the risks of aggressive (or even usual) treatment may outweigh benefits (58,59). In older persons and/or those with substantial comorbid conditions, usual target thresholds for defining high-quality diabetes care (A1c <7.0%, systolic blood pressure <130 mmHg) may actually be harmful due to the risks of hypoglycemia or hypotension (60,61). The need for measures of overtreatment for monitoring and improving quality of care for older persons with diabetes is an ongoing issue (60).

FIGURE 41.14. Frequency of Self-Checking Feet for Sores/Irritations Among Adults Age ≥20 Years With Diabetes, U.S., 2005–2010



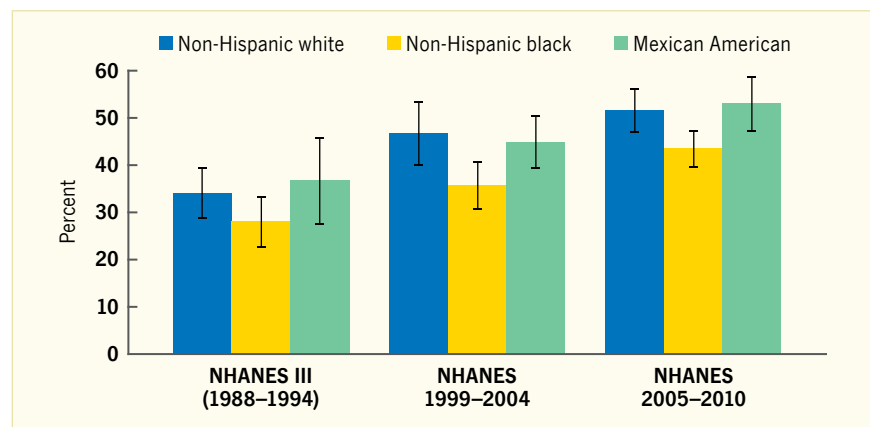
Data are self-reported. Error bars represent 95% confidence intervals.
SOURCE: National Health and Nutrition Examination Surveys 2005–2010

FIGURE 41.15. Age- and Sex-Standardized Percent Distribution of Time Since Pupils Were Last Dilated Among Adults Age ≥20 Years With Diagnosed Diabetes, U.S., 1988–1994 and 2005–2010



Data are self-reported. Estimates are age- and sex-standardized to the National Health Interview Survey 2010 population using age groups 20–39, 40–64, and ≥65 years. Error bars represent 95% confidence intervals.
SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 2005–2010

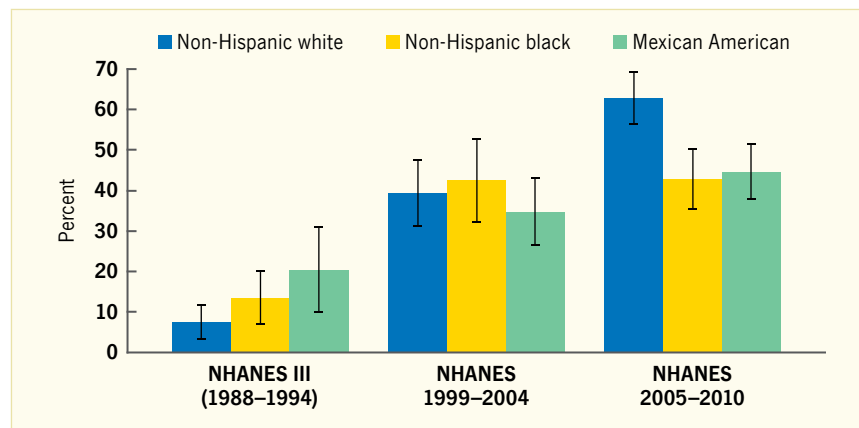
FIGURE 41.16. Age-Standardized Percent With Blood Pressure <130/80 mmHg Among Adults Age ≥20 Years With Diagnosed Diabetes, by Year and Race/Ethnicity, U.S., 1988–1994 and 1999–2010



Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. See Appendix 41.1 for further details.
SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

Studies assessing quality of care at the national level often fail to consider the potential impact of trends in screening and diagnostic practices on risk factor control in the population. It is unclear what proportion of the observed overall trends in improvement in blood pressure, lipid, and glycemic control is due to the changing face of diabetes, improvements in the availability of treatments, or health care quality improvement efforts. Importantly, trends in measures of quality of care may reflect a mix of improvement in care practices, as well as changes in the make-up and characteristics of the patient population.

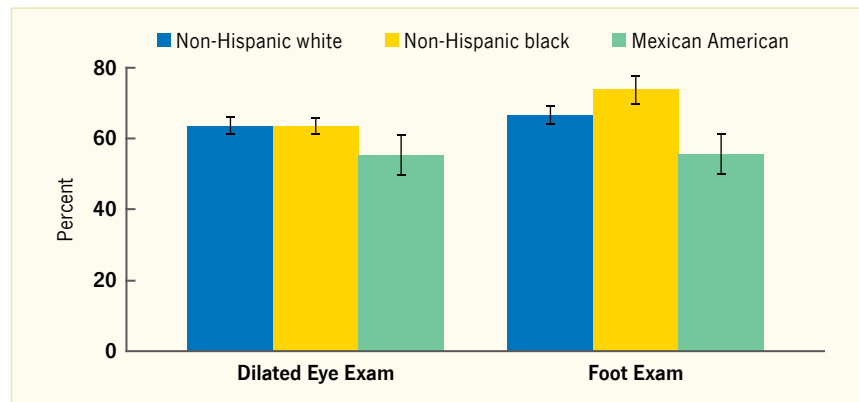
FIGURE 41.17. Age-Standardized Percent With LDL Cholesterol <100 mg/dL Among Adults Age ≥20 Years With Diagnosed Diabetes, by Year and Race/Ethnicity, U.S., 1988–1994 and 1999–2010



Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years. Error bars represent 95% confidence intervals. Conversions for LDL cholesterol values are provided in *Diabetes in America Appendix 1 Conversions*. See Appendix 41.1 for further details. LDL, low-density lipoprotein.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

FIGURE 41.18. Age-Standardized Percent Who Received a Dilated Eye Exam or a Foot Exam in the Past Year Among Adults Age ≥18 Years With Diagnosed Diabetes, by Race/Ethnicity, U.S., 2010



Estimates were age-standardized to the 2000 U.S. Standard Population. Error bars represent 95% confidence intervals.

SOURCE: Reference 56

PERFORMANCE MEASURES AND ORGANIZATIONAL-LEVEL QUALITY IMPROVEMENT INITIATIVES AND RESULTS

Performance measures are tools used to assess the level of diabetes care within a health care system or organization. The criteria used to develop and select performance measures differ from those used for recommendations for individual patients in clinical practice guidelines. These criteria include: (1) the weight and strength of evidence that improving an aspect of care will impact patient outcomes; (2) the absolute risk reduction that will be achieved; (3) a clinician’s likely response to a implementation of a

measure; (4) whether there are distinct subpopulations that may require less or more intensive treatment; and (5) whether most patients would want the recommended medical intervention if they were well informed (11). Another important consideration is the cost of data collection for organizations. These criteria will oftentimes lead to performance measures that differ from recommendations in clinical practice guidelines. The classic example is the evolution of performance measures for A1c over time. As of 2013,

performance measures do not include an A1c <7.0% because of the awareness that subpopulations of patients (particularly older patients) may be harmed by pursuit of this level of control (62). In addition, pursuing this target in all patients may produce modest clinical benefits compared to targeting patients with higher A1c values (63).

Organization-level performance measures include frequency of A1c and lipid testing, percentage of patients above or below

glycemic and cardiovascular risk factor treatment cutpoints (e.g., A1c <8.0%, blood pressure <140/80 mmHg, and/or LDL cholesterol <100 mg/dL), and frequency of microvascular disease screening (e.g., albuminuria, neuropathy, retinopathy). At the national level, the National Committee for Quality Assurance (NCQA) Diabetes Recognition Program recognizes clinicians who have delivered high quality on the basis of such measurements (64). Some groups have adopted combined indicators. In Minnesota, for example, an all-inclusive “optimal diabetes care” measure was adopted as part of the Minnesota Community Measurement Project. This indicator measures the percentage of patients with diabetes age 18–75 years who reach all five of the following treatment goals: A1c <8.0%, blood pressure <140/90 mmHg, LDL cholesterol <100 mg/dL, daily aspirin use for patients with a history of cardiovascular disease unless contraindicated, and tobacco-free status. The Minnesota Project has had mandatory clinical data submission from providers since 2010 and makes summary data available to the community (65).

The HEDIS is a tool used by the vast majority of health plans in the United States (commercial, Medicaid, Medicare, Veterans Affairs) to measure performance and the quality of care being delivered. HEDIS measures are tied to accreditation, are provided to stakeholders

(e.g., consumers, employers, clinicians), and can help in the comparison of performance across organizations. HEDIS performance measures for diabetes care include A1c testing and control, LDL cholesterol screening and control, blood pressure screening and control, and medical attention for nephropathy and retinopathy.

Performance measures have changed as the evidence base for diabetes care has evolved. One of the newest innovations is the interest in developing “tightly linked” quality measures, which typically require electronic medical records to implement (66). These measures identify the presence or absence of a clinical intervention in response to a specific diagnosis or poor intermediate outcome. For example, a tightly linked measure for high cholesterol would be the percentage of patients for whom a doctor prescribed a statin, escalated the statin dose, or had a follow-up cholesterol measurement that was in target range.

A major difficulty in comparing performance measures across organizations is the variation in the clinical characteristics of patients (case-mix) across institutions. The inability to adequately adjust for case-mix is one reason that processes of care measures are preferable to outcome measures. Making comparisons across organizations is also hindered by data

availability. The lack of uniform health information record keeping systems means that the ease of data collection, monitoring, and reporting of performance measures varies substantially across health care organizations. The increasing availability of sophisticated electronic health record systems is expected to improve diabetes performance measurement (60).

Many patients require more intensive care not reflected by general performance measures. The need for individualized care, especially for the most complex patients, can be at odds with usual performance measures. Institutional-level quality control improvement initiatives can significantly improve performance measures, such as frequency of screening and monitoring, but without having a significant impact on control of key individual level risk factors (blood pressure, cholesterol, A1c) (67,68,69). This divide between process improvements and changes in intermediate outcomes has led some to question the validity of commonly used process measures (40,70). Even in studies where system-wide quality improvement initiatives were correlated with improvements in individual-level outcomes, it can be difficult to know whether this association is causal. Ecological designs and the high potential for residual confounding are major limitations of the existing literature (11,71).

ARE THE RIGHT THINGS BEING MEASURED?

As discussed, A1c, blood pressure, and cholesterol control—the “ABCs”—are the mainstays of diabetes care. Other potentially useful, but rarely used, performance measures include treatment intensification among persons with poorly controlled risk factors (“tightly linked” measures) (72), patient satisfaction, diabetes self-management, and lifestyle or nutrition counseling. The evidence base for treatment targets is focused on long-term outcomes (microvascular and macrovascular conditions) in persons with diagnosed diabetes. For many patients, short-term illness and more proximal outcomes, such as quality of life, hypoglycemia, and

treatment burden, may be paramount (73). Outcomes such as cellulitis, infection, influenza, pneumonia, and recurrent hospitalization (especially for heart failure) are important outcomes that are not formally incorporated into diabetes care quality indicators. These complications are associated with substantial expense, particularly if they result in repeated hospitalizations. Other complications include periodontitis, gastroparesis, erectile dysfunction, and depression. From the perspective of the patient and cost to the health care system, short-term clinical outcomes—especially those associated with high rates of hospital

readmission—rather than risk factor control, could be particularly valuable as quality indicators in persons with diabetes.

Increasingly, the narrow focus on the ABCs for improving diabetes care and the use of a common glycemic target in all persons with diabetes, regardless of age or comorbid conditions, is being questioned. A further drawback to the ABCs is that tying payment to these indicators can create an incentive to focus on those patients who can more readily reach the targets (e.g., persons with few comorbid conditions, persons who are already close to target) at the expense

of more complicated patients less likely to achieve treatment goals. The focus of many performance measures is on single risk factors in individuals; however, most individuals have multiple co-existing risk factors, possibly other comorbid conditions, and complex interactions with system-level factors that can impact these quality indicators. Additionally, a focus on specific thresholds fails to recognize risk factor improvements in patients who may still remain above specified levels.

The recognition that “one size may not fit all” is growing; individualized goals may be needed in certain populations (25,74). Indeed, diabetes care guidelines released in 2012 emphasize consideration of patient preference and individualization of therapy and glycemic targets, especially among older individuals and persons with comorbid conditions (25). Existing risk prediction equations and the availability of electronic medical records raise the possibility of future personalized quality

measures that incorporate change over time in a patient’s risk of microvascular or macrovascular outcomes.

A challenge remains that current quality measures are themselves largely not evidence based; adequate data are not available to demonstrate that one quality measure is better than another in improving care, or importantly, in reducing complications of diabetes. This is an area that should be a high priority for research.

QUALITY OF CARE IN SPECIAL POPULATIONS

A large literature base documents substantial age- and race-related disparities in the delivery and receipt of diabetes care. As mentioned, standard targets of care may be particularly difficult to achieve and may not be appropriate among older persons with diabetes (25,75). Providing and evaluating high-quality care among older persons with diabetes is particularly complex because of the high prevalence of comorbid conditions, potentially limited life expectancy, high prevalence of impaired cognition, and the pervasiveness of polypharmacy in this population. Treatment strategies are not well defined in frail elderly persons, patients with long-standing diabetes, and patients prone to recurrent or severe hypoglycemia.

Persistent racial disparities in receipt of appropriate services and risk factor control among persons with diabetes have been widely documented (76,77,78,79,80,81,82,83,84,85,86,87). Racial minority populations are less likely to receive A1c testing or screening for retinopathy compared to whites (88,89). Racial disparities persist even in populations with equal access to health care services (90,91). As shown in the new analyses of the NHANES presented above and in other recent studies (50,92), racial disparities in risk factor control are observed, with black patients with diabetes having higher levels of A1c, blood pressure, and cholesterol than whites (81,91,93).

Regional variation in quality of care indicators for diabetes has also been studied (91), but few measures are available

across all states or other regions to allow for consistent comparison. Better understanding and awareness of regional differences could affect resource allocation and intervention efforts to help ameliorate differences in care.

In the 1970s, approximately 5% of children and adolescents were overweight or obese; in 2010, this prevalence reached 25% (94,95). This astonishing increase in overweight and obesity over the past 30 years among young persons has led to a growing epidemic of type 2 diabetes among children and adolescents. For the first time, a technical report from the American Academy of Pediatrics, published in 2013, lays out specific recommendations for the management of type 2 diabetes in patients age 10–18 years, including guidelines for monitoring of A1c, self-monitoring of blood glucose, and management of cardiovascular risk factors (96). The report emphasizes strategies that have been shown to improve outcomes in pediatric populations, but a paucity of evidence is available to inform the management of type 2 diabetes in young persons. Consequently, much uncertainty remains regarding the best approaches to care in this growing population.

Persons with serious mental illness are at high risk for chronic diseases, including diabetes, and some medications used to treat mental illness are directly implicated in the development of obesity and diabetes (97,98,99). Risk factor control can be particularly complicated and

challenging in this high-risk population, and persons with mental illness may receive less intense medical care and are less likely to achieve treatment targets (100,101,102). However, evidence from a 2013 randomized clinical trial demonstrated that a behavioral weight loss intervention significantly reduced weight over an 18-month period in overweight and obese adults with serious mental illness, suggesting that intensive, tailored interventions can successfully address the high burden of disease and its risk factors in this population (103).

The needs of population subgroups further highlight weaknesses of a narrow focus on the ABCs of quality of care in persons with diabetes and support the 2012 position statement of the ADA and the European Association for the Study of Diabetes that emphasizes the need for individualization of treatment in diabetes (25).

AREAS IN NEED OF IMPROVEMENT

Clearly, quality of care standards for diabetes care will continue to evolve as the evidence base grows and clinical recommendations change. Challenges in measuring quality include: (1) the application of measures to populations that have not been well studied; (2) the ongoing difficulties of case-mix risk adjustment, data availability, quality, and uniformity; (3) addressing disparities in glycemic and cardiovascular risk factor control by age and race; and (4) the development of new or novel performance measures that are consistent with the goals of patients. One of the greatest technical challenges will be developing approaches that account for physicians' efforts to individualize diabetes care, since this is at the core of high-quality clinical practice. How do stakeholders develop measures that reward physicians for the hard task of tailoring goals and treatments to patient health status and patient preferences?

A striking deficiency in efforts to measure quality of diabetes care is the sole focus of current measures on the care of people with established diabetes. Body mass index, widely considered to be the major driver of the current diabetes epidemic, is not a conventional indicator of quality of care. Randomized clinical trials demonstrated that intensive lifestyle modification is effective in preventing or delaying the onset of diabetes among those who are at high risk (impaired fasting glucose, impaired glucose tolerance, or A1c 5.7%–6.4% [39–46 mmol/mol]) (104,105,106). Even modest weight loss (7%–10% decrease in weight) can result in improved glycemic control and prevention of diabetes among those who are at high risk (106). ADA recommendations for persons at high risk of diabetes include weight loss interventions, increasing physical activity, and consideration of metformin therapy (26), although no drugs have been cleared

by the U.S. Food and Drug Administration for clinical use in the prevention of diabetes. Despite the strong evidence base supporting weight loss, lifestyle interventions, and metformin for the prevention of diabetes, measures related to prevention of diabetes are typically not part of the quality of care rubric. Quality indicators almost exclusively focus on treatment of persons with diagnosed diabetes. Quality measures that reflect primary prevention of diabetes and weight loss represent a novel area in need of consideration (60).

Extending quality of care to address prevention of diabetes, hypoglycemia, patient satisfaction, patient quality of life, complications such as infection and pneumonia, medication side effects, and rates of rehospitalization and use of urgent care may not only improve outcomes for individuals but may help identify system factors that could improve care across the board.

LIST OF ABBREVIATIONS

A1c glycosylated hemoglobin	HEDIS Healthcare Effectiveness Data and Information Set
ADA American Diabetes Association	LDL low-density lipoprotein
DCCT Diabetes Control and Complications Trial	NHANES . . . National Health and Nutrition Examination Survey
DQIP Diabetes Quality Improvement Project	UKPDS United Kingdom Prospective Diabetes Study

CONVERSIONS

Conversions for A1c, cholesterol, and glucose values are provided in *Diabetes in America Appendix 1 Conversions*.

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DUALITY OF INTEREST

Drs. Selvin, Narayan, and Huang reported no conflicts of interest.

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APPENDICES

APPENDIX 41.1. Age- or Sex-Standardized Risk Factor Control Among Adults Age ≥20 Years With Diagnosed Diabetes, by Year and Race/Ethnicity, U.S., 1988–1994 and 1999–2010

RISK FACTORS	NHANES III 1988–1994			NHANES 1999–2004			NHANES 2005–2010		
	Non-Hispanic White (N=595)	Non-Hispanic Black (N=416)	Mexican American (N=475)	Non-Hispanic White (N=609)	Non-Hispanic Black (N=372)	Mexican American (N=424)	Non-Hispanic White (N=758)	Non-Hispanic Black (N=573)	Mexican American (N=394)
Mean (standard error)									
Age at diabetes diagnosis (years)	51.7 (0.83)	46.9 (0.90)	49.7 (1.48)	47.7 (0.96)	44.6 (0.84)	43.4 (0.98)	49.8 (0.69)	46.7 (0.56)	45.1 (0.96)
Duration of diabetes (years)	9.5 (0.48)	10.5 (0.62)	7.7 (0.67)	13.6 (0.79)	12.2 (0.74)	11.3 (0.81)	11.2 (0.41)	11.0 (0.42)	10.3 (0.61)
Percent (standard error)									
Diabetes treatment*									
Insulin only	25.1 (2.14)	37.3 (2.32)	18.7 (2.84)	17.1 (2.16)	20.5 (1.89)	10.2 (2.09)	17.0 (1.65)	14.7 (1.53)	12.0 (1.72)
Oral only	44.7 (3.26)	35.4 (2.34)	57.2 (3.81)	54.1 (2.88)	54.7 (2.90)	66.2 (1.75)	54.8 (2.34)	57.2 (2.63)	60.7 (2.37)
Insulin and oral	3.0 (0.74)	6.5 (1.46)	3.9 (0.94)	10.2 (1.86)	12.1 (2.16)	9.0 (1.80)	16.1 (1.28)	15.4 (1.65)	10.2 (1.48)
No meds	27.2 (2.69)	20.8 (2.01)	20.3 (2.80)	18.6 (2.78)	12.7 (1.91)	14.6 (1.63)	12.2 (1.86)	12.7 (1.64)	17.2 (1.91)
Hypertension									
Treated*	45.5 (2.60)	59.0 (2.51)	36.9 (4.29)	55.1 (2.01)	71.3 (3.02)	51.0 (2.41)	63.2 (2.01)	74.4 (2.14)	51.4 (2.20)
Controlled†	17.0 (3.77)	20.3 (3.75)	12.0 (2.94)	39.9 (4.45)	28.3 (3.13)	40.2 (4.60)	45.3 (3.05)	40.1 (2.24)	53.1 (2.54)
Uncontrolled	83.0 (3.77)	79.7 (3.75)	88.0 (2.94)	60.1 (4.45)	71.7 (3.13)	59.8 (4.60)	54.7 (3.05)	59.9 (2.24)	46.9 (2.54)
Blood pressure <130/80 mmHg	34.1 (2.83)	28.0 (2.78)	36.7 (4.76)	46.7 (3.55)	35.7 (2.65)	44.9 (2.89)	51.6 (2.45)	43.4 (2.05)	53.0 (3.04)
Hypercholesterolemia									
Treated*	14.9 (2.05)	14.5 (1.98)	12.8 (4.53) ¹	44.6 (2.73)	30.1 (2.53)	35.4 (3.37)	56.3 (2.43)	48.5 (2.06)	50.5 (3.73)
Controlled†	31.9 (7.63)	21.0 (4.63)	40.2 (12.58) ¹	47.4 (3.64)	53.4 (7.14)	44.6 (5.42)	68.6 (2.82)	59.8 (3.72)	64.6 (4.19)
Uncontrolled	68.1 (7.63)	79.0 (4.63)	59.8 (12.58)	52.6 (3.64)	46.6 (7.14)	55.4 (5.42)	31.4 (2.82)	40.2 (3.72)	35.4 (4.19)
Total cholesterol <200 mg/dL	31.5 (2.82)	34.4 (2.98)	41.9 (4.21)	48.7 (2.16)	56.2 (2.83)	50.0 (2.45)	70.0 (2.17)	61.3 (2.35)	60.5 (2.62)
LDL cholesterol <100 mg/dL	7.4 (2.26) ¹	13.3 (3.42)	20.1 (5.33)	38.7 (4.18)	41.7 (5.23)	34.1 (4.21)	61.7 (3.34)	42.0 (3.73)	43.8 (3.48)
Daily aspirin use	21.1 (2.33)	10.8 (1.84)	8.4 (2.26)	27.5 (2.50)	12.6 (1.79)	16.2 (1.71)	‡	‡	‡
Retinopathy§	14.7 (1.89)	24.7 (2.27)	23.3 (4.09)	23.8 (2.68)	28.7 (2.10)	26.4 (2.15)	19.5 (1.58)	23.5 (1.84)	20.7 (2.15)
Retinopathy	18.8 (3.47)	25.7 (3.57)	25.8 (3.94)	‡	‡	‡	28.7 (2.28)	40.9 (3.80)	39.1 (4.84)
History of CVD¶	20.6 (2.60)	19.7 (2.63)	13.8 (2.37)	26.7 (2.08)	22.4 (2.66)	18.3 (2.07)	25.8 (1.58)	22.6 (1.91)	16.2 (1.47)
Current smoking	18.1 (2.89)	23.5 (3.04)	14.2 (2.14)	19.6 (1.87)	23.1 (2.14)	18.6 (1.69)	17.5 (1.39)	20.0 (1.92)	13.4 (1.78)

Estimates are standardized to the National Health Interview Surveys 2009–2010 diabetic population using age groups 20–44, 45–64, and ≥65 years, except for age at diabetes diagnosis and duration of diabetes, which are standardized by sex to the National Health Interview Surveys 2009–2010 diabetic population. Conversions for cholesterol values are provided in *Diabetes in America Appendix 1 Conversions*. CVD, cardiovascular disease.

* Self-reported use of insulin or diabetes pills; self-reported use of medication to lower blood pressure; self-reported use of medication to lower cholesterol.

† Controlled medication-treated hypertension based on blood pressure <130/80 mmHg; controlled medication-treated hypercholesterolemia based on total cholesterol <200 mg/dL.

‡ Not determined.

§ Based on self-report.

|| Based on fundus photography.

¶ Defined as myocardial infarction and congestive heart failure in the NHANES III 1988–1994, as angina and coronary heart disease were not determined; defined as myocardial infarction, congestive heart failure, angina, coronary heart disease in NHANES 1999–2010.

¹ Relative standard error >30%–40%

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010

APPENDIX 41.2. Risk Factor Control Among Adults ≥20 Years With Diagnosed Diabetes, by Year and Age, U.S., 1988–1994 and 1999–2010

RISK FACTORS	NHANES III 1988–1994			NHANES 1999–2004			NHANES 2005–2010		
	Age (Years)			Age (Years)			Age (Years)		
	20–44 (N=170)	45–64 (N=519)	≥65 (N=808)	20–44 (N=165)	45–64 (N=566)	≥65 (N=805)	20–44 (N=204)	45–64 (N=858)	≥65 (N=928)
Mean (standard error)									
Age at diabetes diagnosis (years)	32.1 (1.02)	47.5 (0.63)	61.3 (0.58)	30.1 (0.81)	43.3 (1.04)	56.1 (0.81)	28.8 (0.98)	45.6 (0.40)	59.4 (0.54)
Duration of diabetes (years)	5.8 (0.83)	8.7 (0.53)	11.7 (0.52)	6.9 (0.84)	11.5 (1.01)	16.8 (0.73)	7.6 (0.73)	9.5 (0.38)	13.5 (0.44)
Percent (standard error)									
Diabetes treatment*									
Insulin only	32.1 (7.09)	19.3 (2.21)	32.1 (1.99)	23.6 (4.04)	10.4 (1.76)	18.7 (1.99)	25.5 (3.22)	13.1 (1.66)	12.6 (1.29)
Oral only	36.1 (7.13)	49.4 (4.10)	41.8 (2.24)	48.7 (4.21)	58.2 (2.74)	56.4 (2.30)	45.2 (3.54)	58.2 (2.50)	61.2 (2.43)
Insulin and oral	³	5.2 (1.22)	2.1 (0.62)	4.4 (1.60) ¹	12.6 (2.20)	10.4 (1.50)	9.5 (2.38)	15.4 (1.16)	15.1 (1.74)
No meds	28.5 (5.78)	26.2 (3.39)	24.0 (2.36)	23.3 (4.28)	18.7 (2.31)	14.5 (1.77)	19.7 (2.89)	13.3 (1.60)	11.2 (1.53)
Hypertension									
Treated*	23.8 (4.38)	50.2 (3.27)	52.1 (2.69)	25.6 (3.84)	55.2 (2.50)	69.6 (2.22)	35.4 (3.70)	64.1 (2.41)	72.3 (1.91)
Controlled†	23.0 (8.40) ¹	18.2 (4.46)	13.5 (2.98)	26.1 (7.61)	39.8 (4.20)	30.5 (3.13)	43.0 (7.43)	48.8 (3.02)	37.1 (1.88)
Uncontrolled	77.0 (8.40)	81.8 (4.46)	86.5 (2.98)	73.9 (7.61)	60.2 (4.20)	69.5 (3.13)	57.0 (7.43)	51.2 (3.02)	62.9 (1.88)
Blood pressure <130/80 mmHg	59.3 (6.72)	33.5 (3.01)	21.5 (2.27)	53.8 (5.65)	48.1 (3.38)	30.9 (2.84)	57.1 (4.45)	54.8 (2.49)	42.6 (1.85)
Hypercholesterolemia									
Treated*	5.7 (2.75) ²	16.1 (3.17)	16.7 (1.90)	28.6 (4.87)	41.5 (2.92)	44.1 (2.18)	36.5 (3.62)	57.7 (2.35)	55.5 (2.01)
Controlled†	³	33.2 (10.48) ¹	25.5 (6.94)	30.2 (9.66) ¹	45.3 (4.10)	57.1 (4.32)	53.1 (7.51)	58.2 (3.33)	79.2 (2.80)
Uncontrolled	62.7 (28.04) ²	66.8 (10.48)	74.5 (6.94)	69.8 (9.66)	54.7 (4.10)	42.9 (4.32)	46.9 (7.51)	41.8 (3.33)	20.8 (2.80)
Total cholesterol <200 mg/dL	45.1 (9.00)	26.6 (3.40)	36.7 (2.53)	44.1 (4.93)	47.4 (2.81)	55.2 (2.74)	62.2 (3.89)	60.8 (2.32)	76.7 (1.84)
LDL cholesterol <100 mg/dL	³	11.5 (4.15) ¹	12.4 (3.06)	40.2 (7.21)	32.1 (4.47)	43.9 (5.12)	47.1 (6.95)	52.2 (3.60)	61.6 (2.81)
Daily aspirin use	6.5 (3.02) ²	16.4 (3.08)	25.9 (2.58)	8.8 (3.48) ¹	20.8 (3.08)	30.0 (2.29)	‡	‡	‡
Retinopathy§	11.5 (3.77) ¹	18.2 (2.17)	17.7 (1.78)	25.2 (4.64)	24.0 (2.61)	26.3 (2.34)	20.1 (3.47)	20.3 (1.96)	21.4 (1.38)
Retinopathy	21.2 (9.67) ²	18.5 (2.44)	21.7 (2.90)	‡	‡	‡	20.6 (6.53)	33.1 (3.11)	34.7 (2.40)
History of CVD¶	1.1 (0.52) ²	17.9 (3.02)	30.5 (2.95)	5.5 (2.11) ¹	19.4 (2.50)	38.6 (2.56)	5.0 (1.58) ¹	19.9 (1.47)	34.9 (1.93)
Current smoking	31.6 (6.46)	21.6 (3.31)	9.6 (1.33)	34.7 (4.23)	26.0 (2.29)	7.4 (1.37)	26.0 (3.85)	20.9 (1.62)	7.8 (0.69)

Estimates are crude and not standardized. Conversions for cholesterol values are provided in *Diabetes in America Appendix 1 Conversions*. CVD, cardiovascular disease.

* Self-reported use of insulin or diabetes pills; self-reported use of medication to lower blood pressure; self-reported use of medication to lower cholesterol.

† Controlled medication-treated hypertension based on blood pressure <130/80 mmHg; controlled medication-treated hypercholesterolemia based on total cholesterol <200 mg/dL.

‡ Not determined.

§ Based on self-report.

|| Based on fundus photography.

¶ Defined as myocardial infarction and congestive heart failure in the NHANES III 1988–1994, as angina and coronary heart disease were not determined; defined as myocardial infarction, congestive heart failure, angina, coronary heart disease in NHANES 1999–2010.

¹ Relative standard error >30%–40%

² Relative standard error >40%–50%

³ Estimate is too unreliable to present; ≤1 case or relative standard error >50%.

SOURCE: National Health and Nutrition Examination Surveys (NHANES) III (1988–1994), 1999–2010